

**Texas Commission on Environmental Quality
New Technology Research & Development (NTRD) Program
Monthly Project Status Report**

Contract Number: 582-11-13472-2019

Grantee: Transportation Power, Inc.

**Report for the
Monthly period:** 10/08/11 – 11/11/11

**Date
Submitted:** 11/14/11

Section I. Accomplishments

Provide a bulleted list of project accomplishments as well as a description of their importance to the project.

- Completed testing and calibration of the battery management system (BMS) installed on our first test battery pack. A ground fault protection unit was also selected and integrated with the pack to provide added safety. This is important to the project because, while the test battery pack is presently installed on a Navistar truck, it is electrically nearly identical to the packs to be installed on the electric terminal tractors. It consists of 120 large lithium-ion cells with a total energy storage capacity of 100 kilowatt-hours (kWh). The electric tractor battery pack will consist of 120 lithium-ion cells which will be the same size as those in the test pack, but will have about 15% more energy capacity.

Figure 1. Test battery pack with BMS and ground fault hardware fully integrated.



- Initiated bench testing of our advanced onboard inverter-charger, which is important because this begins the process of validating one of the major components required for electrification of the terminal tractors. Testing will continue for approximately three months, after which any needed design changes will be made and the units to be used on the electric tractors will be assembled.

Figure 2. Inverter-charger hardware configured for bench testing.



- Completed assembly of a test version of our High Voltage Distribution Center (HVDC), which routes high-voltage power from the battery pack to the inverters that control the electric motors and the electrically-driven accessory subsystem. Control code was created and underwent initial calibration to govern accessory start up and vehicle starting safety. High voltage pre-charge and contactor control was verified. DC-DC production of 12 volt system power was verified and connected to the 12 volt supply on our Navistar test truck. As with the battery subsystem, the HVDC subsystem is also installed on our Navistar test truck, but its design will be replicated for the electric terminal tractors. The Navistar truck in these cases is being used in lieu of a bench test setup to provide a more accurate platform for testing and evaluation of all of our prototype subsystems and components.

Figure 3. High Voltage Distribution System.



- Initiated facility modifications required prior to removal of the diesel engine from the first terminal tractor. During the reporting period we learned that the City of Poway requires installation of a vent system for any facility housing diesel engines or fuel systems, even when the systems are not going to be used. This came as a surprise to us and we are doing our best to expedite installation of the required vent system.

Indicate which part of the Grant Activities as defined in the grant agreement, the above accomplishments are related to:

- The first three accomplishments listed above relate to Task 2.1.1, “Final Component Selection and Procurement.”
- The fourth and last task above relates to Task 2.2.2, “Tractor Installation.”

Section II: Problems/Solutions

Problem(s) Identified: Report anticipated or unanticipated problem(s) encountered and its effect on the progress of the project

- a) Tractor 1 installation cannot begin until the diesel engine and fuel system are removed from the vehicle, and this task cannot be performed until a vent system is installed in our facility. This is not expected to have a significant effect on the progress of the project because we are still in the process of testing and validating the components to be used on the tractor and have been able to utilize a separate Navistar test truck for these purposes.
- b) Drive testing of the Navistar test truck – the final stage of testing before component designs are finalized – was delayed due to unexpected problems that occurred during pre-driving tests of the integrated system. The most serious of these issues was a failure of one of the Quantum inverters used to power the electric motors in the Navistar truck. While we still have one working inverter, we have been devoting substantial efforts to analyzing the cause of this failure before drive testing the vehicle.

Proposed Solution(s): Report any possible solution(s) to the problem(s) that were considered/encountered

- a) We considered removing the engine and fuel system from Tractor #1 in a different facility to resolve the vent issue. While this would have been a faster and less costly solution, it would have been only a temporary fix, and the cost of moving all vehicles with engines to remote facilities to remove them would eventually far exceed the cost of installing a vent system in our own facility.
- b) We considered pushing ahead with drive testing of the Navistar test truck with our one working Quantum inverter. While this would have accelerated the test schedule, we felt it would also increase the risk of damaging our one remaining Quantum inverter, which is a long lead item that could take several weeks to replace. The other option was to remove the working inverter and perform additional testing on it prior to attempting to drive the Navistar test vehicle with it. We considered accelerating work on Tractor #1 by hiring additional engineers to advance its design while our current team completes integration testing on the Navistar vehicle.

Action(s) Conducted and Results: Describe the action(s) taken to resolve the problem(s) and its effect

- a) A meeting was held with the landlord to discuss the vent installation issue on November 11 and he was very helpful. A contractor has been contacted to install the vent and it is expected to be installed during the next reporting period. This will enable the engine and fuel system in Tractor #1 to be removed well before the end of the year, permitting us to begin installing electric drive components in early 2012.
- b) Additional tests of the Quantum inverter have been completed and new software and hardware have been developed to reduce the risk of its failure. We also began the process of obtaining a replacement for the failed inverter and at least one spare inverter from Quantum. These particular issues are not expected to have any long-term effect on the electric tractor project because the Quantum inverter is to be used only as a backup for the tractor project, with our own inverter-charger being the primary component used

for motor control. Other issues with the integrated system on the Navistar test truck, while frustrating in the delays they caused, have nearly been resolved and the truck is expected to be in full drive testing within the first week or two of the next reporting period. This will allow our engineering team to shift its focus to the design of the electric tractor installation and will permit our team to begin ordering components and parts for the tractor well before year-end. Hiring additional staff was ruled out because the time required to recruit and train new people would exceed the time we expect it to take to shift the focus of our existing team on the electric tractor design. In any event, all of the experience being gained with the components on the Navistar test truck is extremely valuable and applicable to the electric tractor project, and should enable work on the tractors to proceed more rapidly and with a reduced chance of encountering significant problems.

Section III. Goals and Issues for Succeeding Period:

Provide a brief description of the goal(s) you hope to realize in the coming period and identify any notable challenges that can be foreseen

During the coming period our main goal is to execute our plan for accelerated integration of components into the first vehicle. We expect to remove the diesel engine and fuel system from the vehicle, which was delayed due to factors discussed earlier in this report. We are in the process of developing a preliminary layout of the major drive system components in the first tractor, and expect to have documentation of the planned installation, along with a more detailed schedule for tractor completion, by the end of the next reporting period.

Date: 11/14/2011

Authorized Project Representative's Signature

NOTE: *Please attach any additional information that you feel should be a part of your report or that may be required to meet the deliverable requirements for tasks completed during this reporting period.*